In search of the elements of an Intra-organizational Innovation System for Brazilian automotive subsidiaries

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Abstract: The present study provides a theoretical basis for the development of product technological competence in global automotive organizations in Brazilian subsidiaries. It is argued that the necessary knowledge is fragmented in literature among studies on new product development, knowledge management and organizational learning, organizational competences and technological innovation.

It presents two concepts: (a) the concept of Intermediate Technological Leadership (ITL), as an enterprise purpose to be reached and (b) the concept of Intra-organizational Innovation System (IIS), as a model to be constructed and applied in local subsidiaries in order to enable the achievement of all necessary technological competences. The integration of theoretical sources reveals six fundamental elements for an IIS: strategic adequacy, interpretation of external environment, conception of internal organizational structure, integration of external structure, systematization of organizational basic processes, and consideration of human factors and relationships. It is expected that the theoretical basis presented in this study will serve as a reference to be validated in real-world applications.

Key Words: Technological innovation systems, organizational competences, new product and technology development, automotive industry.

Introduction

Product development in Brazilian automotive industry has been aggregating new methods and technologies due to the legislative requirements, market needs and new organizational strategies. Since the great market opening occurred in the nineties, this industrial sector has been experiencing a fast transformation of its subsidiary structures. Such transformation aims at a continuous preparation of these local organizations for a more competitive market.

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There are many purposes that motivate different countries to involve themselves in companies' Product Development Programs. Among them, the use of subsidiaries' competences and reduction in development cost can be emphasized. In the Brazilian case, local market demands and particularities have been the basis for investments in R&D [12]. Within this context, this paper will begin by presenting an analysis of the main theoretical studies that form the basis of this article's central argument. Following this, it will discuss the role played by the Brazilian subsidiaries of worldwide organizations. It will, then, present the concept of Intermediate Technological Leadership, and will propose a theoretical model that shows six fundamental elements for an IIS. It will be argued that this model should be the main theoretical foundation for a practical IIS implementation. The final section will discuss the applicability and the relevance of this study.

The theoretical basis

Knowledge management and organizational learning

Nonaka and Takeuchi are seen as essential references on knowledge creation for technological innovation [17]. Representing the Japanese approach, these authors affirm that the success of Japanese companies mainly happened due to their abilities in organizational knowledge creation, which they define as being the capacity a company has to create knowledge, to spread it within the organization and to incorporate it into products, services and systems.

The acquired learning or created knowledge takes the form of new concepts of products, archetypes, procedures or services. In the western approach, Senge, Dibella and Nevis, and Argyris and Shön, present strategies of organizational learning emphasizing more explicit knowledge than the Japanese does [24, 6, 1]. Nonaka and Takeuchi center their organizational knowledge creation theory in four mechanisms for knowledge conversion: Tacit-Tacit (socialization), Tacit-Explicit (externalization), Explicit-Explicit (combination) and Explicit-Tacit (internalization) [17]. Such mechanisms have been identified throughout studies and reviews of innovative processes in Japanese organizations. Both approaches recognize organizational characteristics such as managers' roles, people's autonomy, objectives, *etc*., and discuss the ideal conditions for learning process improvement.

Organizational competences

In any organization beginning to develop new products and technologies, there are activities, work processes, physical structures, organizational and professional profile definitions that have not been there before. Organizational Competences refer to the systematization of all these necessary elements which will sustain new abilities now present within the organization.

Prahalad and Hamel studied the concept of competences focused on product's base technologies. According to them, core competences are related to the

product's base technological domain, and this would be the major argument to explain the difference between technology-based corporations [20]. Prahalad and Hamel present an important relation between competence formation and innovative dynamics as they recognize that companies, which are not focused on technological abilities, are increasingly more limited in identifying innovative ways in their current product line or simple expansions [20].

For the organizational competence formation, a careful consideration of local context is highly necessary, as the differences between local and foreign environments are very relevant. It is also important to consider strategic alliances which are normally focused on the complementarity of strength and weakness. Such strategies are commented by Fleury and Fleury, Prahalad and Hamel and Medcof [11, 20, 14].

New product development process

Before launching a new product in a local market, there must be a stage-structured process that managerially leads it to market – a process called PDP (Product Development Process). PDP is applied from needs identification (customers' needs, technological tendency, legislative criteria, *etc*.) and choice of product concept up to its commercial launch. PDP divides the pioneering product into a list of stages, each one constituted by a list of prescribed, multifunctional and parallel tasks [4].

According to Cheng, different approaches and background of each author have produced different perspectives of PDP [2]. For instances, Clark and Wheelwright and Pugh are authors who bring us a product engineering perspective [3, 21]; whereas, Dolan and Cooper look at PDP from the marketing perspective [7, 4]. Meyer's concept of platform identifies the relationship between structural and technological approach and product development strategies [15]. Griffin and Page search for common points among companies and propose a list of best practices in New Product Development (NPD) environment [13].

Technological innovation taken from the economic perspective

In economics approach, technological innovation acquires prominence from the moment when it appears as a competitive advantage. The works from the economics perspective have origin in the neoclassic economic theories, in which Schumpeter constitute a very important reference [23]. It can be stated that this approach takes an external view of the organizational structures, but it does not make indepth discussions about Intra-organizational processes. Pavitt, Nelson and Winter, amongst others, are also considered reference authors [19, 16]. The most important elements of their analysis are frequently competitiveness, investment politics, innovative pay-back, rate of economic growth within organizations and countries, creation and conduction of strategies within subsidiaries, and the innovation as a dynamic market key element.

In Brazil, this approach becomes more relevant, mainly among those who see a sustainable way for economic and social development through technological

innovation. It can be noted that they are mainly from research institutes such as IPEA and from the main local universities [22].

Innovation in companies from emergent countries

The theoretical bases examined in the previous sections consider complementary aspects of product and technological innovation within industrial organizations. However, very little integration of different theories could be found. This context reinforces the need to construct a model for technological innovation that is appropriate to emergent countries.

Few authors have tried to integrate knowledge from this theory in search of models applicable to the specific context of companies located in Brazil. Amongst those, Fleury and Fleury study Brazilian innovative context more actively, assessing Intra-organizational aspects [10]. More specifically, Figueiredo presents an integrated and contextual model for companies in emergent countries, examining the trajectories of accumulative technological competence, their relation to underlying learning processes, and their impact on the operational performance within companies [8].

Figueiredo explains "learning" as a two-dimensional term: the trajectory of accumulative technological competence within an organization and the processes by which individual knowledge is transformed into physical systems, production processes, procedures, routines, products and services. External and internal knowledge acquisition processes are crucial for companies in emergent countries, yet they do not have any previous knowledge background. Such study concludes with a close relation with the basic characteristics of knowledge acquisition process, the rhythm, the consistency and the composition of trajectories of accumulative technological competence [8].

R&D centralization and decentralization: the roles of Brazilian subsidiaries in worldwide organizations

R&D competence development will occur in a subsidiary according to its autonomous level within a worldwide organization. When local R&D occurs, it tends to be more directed to local market characteristics. Moreover, it is considered successfully accomplished when a subsidiary develops local competitive strategies, establishes complex organizational structures, develops products for local market, and also elaborates proper management systems. It is also observed that local governments are concerned with attracting foreign investments through local infrastructure creation that could potentialize the subsidiary competitiveness within global competition [9].

Fleury identifies three different subsidiary categories in Brazil. The first category is of subsidiaries that act as the operational arm of headquarter. The third one is of subsidiaries that work as a competence center, guaranteeing the autonomy in local market according to its own technological competence. The second category is of subsidiaries that remain in an intermediate phase as a relatively

independent unit [9]. Other classifications in specialized literature concerning the subsidiary roles can be found [5, 12].

There are several evidences of increasing product and technological development activities in Brazil. The contact with new knowledge, new technologies, flexibility and agility for product adaptations, lower development costs, incentive taxes, and requirements for local performance are some of the main aspects involved in the process [12]. It is important to define an appropriate level of autonomy and also a suitable resource allocation for R&D within the subsidiary. It aims at best exploration of local opportunities.

The Brazilian automotive sector is dominated by foreign companies, which means that Brazilian insertion in technological development will also depend on strategies of those organizations. Dias affirms that Brazil can be consolidated as an important product development basis for worldwide market, by developing specific products for some market niches or by specializing in specific subsystem development. Thus, after developing satisfactory competences to local market, a subsidiary becomes a strong developed site for countries and markets with similar characteristics to its own [5].

Brazilian automotive engineering began to adapt some foreign vehicles transmissions in the sixties. Today, in some subsidiaries, there is competence to develop a complete vehicle. As examples of local competence development, General Motors do Brasil can be cited as one of the five development centers of GM group in the world. A few years ago Fiat presented its Brazilian product development center as the first one outside Italy. Ford and Volkswagen have gradually more Brazilian engineers involved in international product developments. The interesting point in these involvements is that the direction of knowledge flow has being inverted in many recent cases. Currently, Brazil is the 11^{th} automobile world-wide producer and the first in South America [18].

Intermediate Technological Leadership

In this article, we present the concept of ITL, or Intermediate Technological Leadership, to explain some purposes which have been recently observed in the context of Brazilian automotive industry. To be in search of Intermediate Technological Leadership consists in implementing a strategy to extend the local competence in product and technological development.

One of the main assumptions of ITL is the integration of product development site and its physical location within a local market limits. It can be regarded as the best alternative to a fast understanding of the specific market rules and to select and develop specific products and technologies to that market. So, it can be defined as "ITL stimulated by local market", considered here as an ITL sub-category that occurs when local market is the main factor that fosters the technological competence formation. A second sub-category of ITL is identified when technological competence development is justified by exclusiveness, business share, or when a development site seeks to become a technical reference in the development of new product or subsystem among other sites of the same industrial group. In this case, an internal competition is expected to happen within the

subsidiaries. This sub-category is called "Intermediate Technological Leadership stimulated by internal competition".

The road-map to ITL: identifying the necessary elements of an Intra-organizational Innovative System

In the context of this article, a particular system that provides for any organization's accomplishment of ITL is called Intra-organizational Innovative System (IIS). This section summarizes the integration of different theories which contributed to the identification of the foundations of IIS .

Figure 1 tries to integrate the main points of view of each theory cited in section 2 and the industrial context identified in section 3. The theory contributions explored in this article have been organized into six distinct elements. Each element represents a vital area of a complete IIS:

- **Strategic adequacy:** it considers the subsidiary local autonomy, its defined role in the global organization, the headquarters' dependence in adopting or not of an ITL position, and the local capacity that influence it. The main sources that explore this element are found in the specialized literatures of organizational competence and technological innovation, more specifically within the topic of organizational arrangements.
- **Interpretation of external environment:** it aims to consider legislation, tax incentives, local market needs and many other constraints that influence directly the product portfolio strategy. The PDP literature approaches these points focusing on design inputs, whereas the technological innovation literature approaches them as strategical decision parameters.
- **Conception of internal organizational structure:** it aims to establish the characteristics of physical environment and work division. The literatures on PDP and Knowledge Management complement the topics related to the organizational structure for product development.
- **Integration of external structure:** it considers the contact with knowledge and competences which are outside the organization limits (universities, research centers, *etc*.). Strategic alliances are well takled by Organizational Competence literature, however, the other topics are more detailed by technological innovation literature.
- **Systematization of organizational basic processes:** it considers the New Product Development Process and those related to the continuous organizational learning. They are largely discussed in product development literature with great contributions from knowledge management studies.
- **Consideration of human factors and relationships:** this element is more related to human behaviors. Specific studies, focused on organizational culture, industrial psychology and human resources are potential sources of knowledge for these topics.

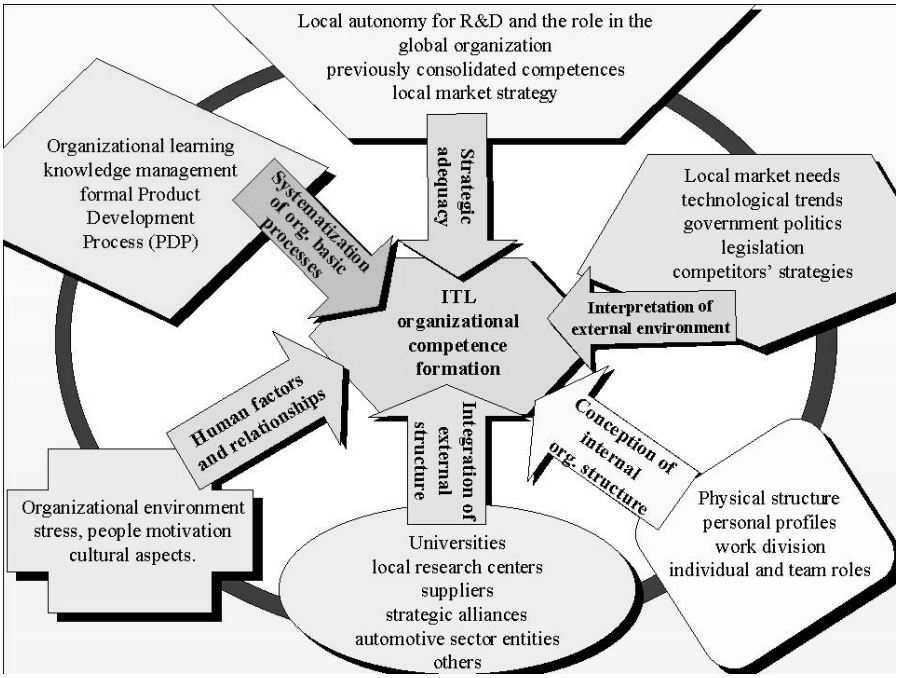

Figure 1. Fundamental elements of an Intra-organizational Innovative System

Conclusion

The formation of technological competence within the context of ITL presents great social and economic relevance for a country's development. This article aimed to provide an important way for changing the roles currently played by Brazilian subsidiaries within their organizations. This change includes setting new forms of investment attraction, valuing more highly jobs generated in Brazil, and also motivating the development of organizations that compose the structure for local innovative support system. Such reality, however, should be based on complete IISs, conceived from a rigorous theoretical search, and has to be carefully integrated into practical environment. Each singular organizational context will demand a specific and adequate system.

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